

# The Ins and Outs of Patterns

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**Reporting Category** Pattern, Function, and Algebra

**Topic** Exploring patterns

## Materials

- Directions for Making the Input-Output Machine (attached)
- Large cardboard box
- Tape
- Foil or decorative wrapping paper (optional)
- Paper towel tube
- Utility knife
- Glue
- Markers
- Index cards
- Picture cards of dogs and dogs' legs (teacher-made)
- Packs of gum (or pictures of packs of gum and individual sticks of gum)
- Input-Output Tables (attached)
- Ins and Outs of Patterns Recording Sheet (attached)
- Ins and Outs Scenario Cards (attached)

## Vocabulary

*pattern, table, rule, function, growing, repeating, extending, numeric pattern, geometric pattern*

## Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Note: Before undertaking this activity, construct an "Input-Output Machine" according to the directions given on the attachment. Also, prepare picture cards of dogs and dogs' legs on index cards, as described in step 1 below.

1. Explain to students that they will be analyzing patterns and determining the relationships between the inputs and the outputs of numbers from an "Input-Output Machine." Display the machine, and explain that when a number is put into the INPUT slot, the machine has a *rule* or *function* it follows to determine the number that comes out of the OUTPUT slot. Demonstrate how this works by using the picture cards of the dogs. Ask a student to put one dog into the INPUT slot and then to take the card that comes out of the OUTPUT slot (picture of 4 legs). Ask the student to state how many dogs went into the INPUT (1) and how many legs came out of the OUTPUT (4). Ask students how many legs will come out of the OUTPUT when 2 dogs go into the INPUT. Show this process, as well as the processes for 3 dogs and 4 dogs. Display the resulting data in a table like the one at right.

Number of dogs (input)	1	2	3	4
Number of legs (output)	4			

2. Ask students if there is a relationship between the input numbers and the output numbers. When they say yes, have them explain it by comparing the input numbers to the output numbers. Finally, ask students to state the rule or function of the machine this time as indicated by the numbers in this input-output table.

Packs of gum (input)	Sticks of gum (output)
1	5
2	
3	
4	

3. Tell students that they will be looking at another example together. Explain that this time, they will discover the relationship of a pack of gum (input) to the number of sticks of gum that come out (output). This time, display the number in a vertical input-output table like the one shown at right.
4. Have a student put a pack of gum (or a picture of a pack of gum) into the INPUT slot, and slide 5 sticks of gum (or pictures of 5 sticks) out of the OUTPUT slot. Record in the table that 1 pack of gum went in and 5 sticks came out. Next, have a student put 2 packs of gum into the INPUT slot. Record that number in the table, and ask students to predict the output number, based on comparing the first input and output numbers (1 and 5). Ask students how they know the output will be 10, then demonstrate 10 sticks of gum coming out the OUTPUT. Ask students whether the output is increasing, decreasing or remaining the same compared to the input. Challenge students to state the rule or function of the machine this time. Then, ask them for output numbers for 3 packs of gum and 4 packs of gum, and record these numbers in the table.
5. Discuss the relationship between the input numbers and the output numbers, and lead them to see that  $5 + 5 = 10$ , then  $5 + 5 + 5 = 15$ , and then  $5 + 5 + 5 + 5 = 20$ . Ask students whether there is another way to determine the output number. (skip counting by fives or multiplying the input number by 5) Go over the strategies for identifying the rule of an input-output table:
- Look at the first input and output numbers to determine what is happening.
  - Determine the relationship of the numbers: Is the output increasing or decreasing?
  - Determine the operation used to increase a number. (add or multiply)
  - State the rule of the table.
  - Determine whether the rule is correct by using it with another input number.
6. Distribute copies of the Input-Output Tables. Give several other examples, and have students record the input and output numbers in both horizontal and vertical tables. In some examples, challenge students by using numbers other than 1 to begin an input table. For example: "Joe wants to purchase a CD from the store. The store has advertised that CDs are on sale for 2 for \$12.00, 3 for \$18.00, and 4 for \$24.00. Joe wants to purchase 5 CDs. How much will it cost him?" Have students put this data into an input-output table. Ask, "If the input starts with the cost of 2 CDs, how do you determine the cost for 1 CD?"
7. Distribute copies of the Ins and Outs of Patterns Recording Sheet. Put students into pairs, and explain that pairs will work with the tables to discover patterns and the relationships between input and output numbers. Rotate copies of the Ins and Outs Scenario Cards among the pairs, and have partners work to determine the input-output data for each scenario, put them in the table, and write the rule for the scenario based on the data in the table. Have a representative from each pair share with the class the pair's strategies and answers for the scenarios.

## **Assessment**

- **Questions**

- How do you determine the output numbers in an input-output table?
- What strategies do you use to figure out the relationship between the input and output numbers?
- How can you justify or prove that your rule for an input-output table is correct?

- **Journal/Writing Prompts**

- Explain the strategies you should use to figure out the relationship between input and output numbers.
- Your teacher gives you a card with an input/output table on it that is partially completed. Attach the table to a page of your journal, and complete table. Then, write a justification for your answers and reasoning.

## **Extensions and Connections (for all students)**

- For students who have difficulty with the concept of using numbers in input-output tables, the use of pictures or images can be helpful to understanding. For example, ask students to complete a table that shows the relationship of eyes to students. Ask one student to come to the front of the room and “go in the INPUT slot.” Then, slide a card with a picture of 2 eyes out of the OUTPUT slot: input number = 1, output number = 2.
- Use pattern blocks as input and numbers of sides as output.

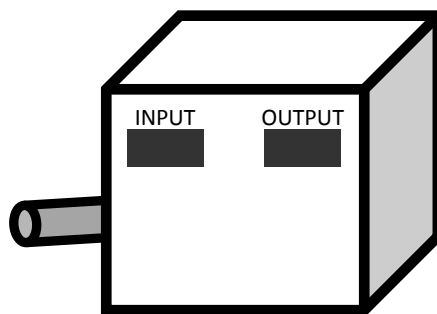
# Directions for Making the Input-Output Machine

## Materials

- Large cardboard box
- Tape
- Foil or decorative wrapping paper (optional)
- Paper towel tube
- Utility knife
- Glue
- Markers
- Index cards

## Directions

1. Tape the top flaps of the box closed. Cut off one side of the box so that access to the inside of the box from the back is unimpeded.
2. Cut two rectangular slots on one side of the box. The slots should be about 6 inches wide and 2 inches high so that the index cards can pass through easily. The slots should be side by side with about 6 to 8 inches between them. Wrap the box in foil or decorative wrapping paper (optional).
3. Write the word INPUT above the left slot and the word OUTPUT above the right slot. Then, wrap the paper towel tube (optional), and glue it to the left side of the machine. This is the handle that is “pulled” to cause the machine to perform the “rule” and make a card come out of the OUTPUT slot.



# Input-Output Tables

Name: \_\_\_\_\_ Date: \_\_\_\_\_

RULE: \_\_\_\_\_

INPUT	OUTPUT

RULE: \_\_\_\_\_

INPUT	OUTPUT

RULE: \_\_\_\_\_

INPUT	OUTPUT

RULE: \_\_\_\_\_

INPUT	OUTPUT

RULE: \_\_\_\_\_

INPUT	OUTPUT

RULE: \_\_\_\_\_

INPUT	OUTPUT

RULE: \_\_\_\_\_

INPUT					
OUTPUT					

RULE: \_\_\_\_\_

INPUT					
OUTPUT					

RULE: \_\_\_\_\_

INPUT					
OUTPUT					

# Ins and Outs of Patterns Recording Sheet

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Directions: Determine the input and output for each scenario on the Ins and Outs Scenario Cards. Record the inputs and outputs in the tables below. Write the appropriate rule for each.

SCENARIO A	
Rule:	
INPUT	OUTPUT

SCENARIO B	
Rule:	
INPUT	OUTPUT

SCENARIO C	
Rule:	
INPUT	OUTPUT

SCENARIO D	
Rule:	
INPUT	OUTPUT

# Ins and Outs Scenario Cards

Copy cards on cardstock, and cut apart on the dotted lines.

## SCENARIO A:

A triangle goes into the INPUT of the machine, and the number 3 comes out of the OUTPUT. Two triangles go into the INPUT of the machine, and the number 6 comes out of the OUTPUT. If the pattern continues, what is the OUTPUT for 4 triangles? Complete the table.

## SCENARIO B:

An ant crawls into the INPUT of the machine, and a picture of 6 legs comes out of the OUTPUT. Two ants crawl into the INPUT of the machine, and a picture card of 12 legs comes out of the OUTPUT. If the pattern continues, what is the OUTPUT for 4 ants? Complete the table.

## SCENARIO C:

Mary has a lemonade stand. The cost of one cup of lemonade is 7¢. If the pattern continues, what is the OUTPUT if she sells 4 cups of lemonade? Complete the table for 1 cup sold, 2 cups sold, etc.

## SCENARIO D:

Jerry can buy 2 subs at a cost of \$6. He can buy 4 subs at a cost of \$12. If the pattern continues, what is the OUTPUT if he buys 8 subs? Complete the table.